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DESCRIPTION OF EGGS AND LARVAE OF THE SUMMER FLOUNDER, *PARALICHTHYS DENTATUS*

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By W. G. Smith and Michael P. Fahay

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UNITED STATES DEPARTMENT OF THE INTERIOR
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ABSTRACT

Summer flounder eggs and larvae are described from artificially fertilized specimens and from material collected at sea. Diameter of the pelagic egg ranges from 0.90 to 1.10 mm with a mean of 1.02 mm. Diameter of the single oil globule ranges from 0.18 to 0.31 mm with a mean of 0.25 mm. At hatching, the larva lacks eye pigment, fin buds, and mouth parts. The posterior quarter of the larva is unpigmented. The body begins to flatten laterally at about 7.5 mm. The right eye begins migrating to the left side of the skull and the urostyle tips up at about 9.5 mm. Median fin rays are largely formed between 9.0 and 10.0 mm with anal fin rays appearing last. Median fin ray counts fall within the adult range of 13.0 mm. A significant difference is noted in pigmentation and development with size between specimens examined and those described as *Paralichthys* sp. by Hildebrand and Cable (1931).

DESCRIPTION OF EGGS AND LARVAE OF THE SUMMER FLOUNDER, *PARALICHTHYS DENTATUS*

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Current knowledge of larval morphology of the summer flounder, *Paralichthys dentatus,* is based primarily on collections taken in North Carolina waters, where this species mingles with two other members of the genus, *P. lethostigma* and *P. albigutta.* The morphological similarities of the three have presented a major obstacle to those interested in identifying the initial stages of any of these species.

Hildebrand and Cable (1931) first described larval *Paralichthys* from samples taken near Beaufort, N. C., but they were unable to make specific identifications and thus treated all members as a single group.

Deubler (1958) separated postlarvae of the three species using a combination of meristic criteria. He further distinguished *P. dentatus* from the other two species of the genus by pigment characteristics of the dorsal and anal fins. His specimens, taken in North Carolina inlets and sounds, include no summer flounder smaller than 9 mm standard length (SL). Deubler's work is valuable for identifying postlarval and juvenile *Paralichthys,* but meristic counts are unsatisfactory for identifying earlier larval stages because the characters used are not fully developed.

More recently Woolcott, Beirne, and Hall (1968) published a study on comparative osteology of the three species. Their specimens, all from North Carolina estuaries, ranged from 10 to 130 mm SL. Although these authors noted a few interspecific differences in morphology of developing bone, like Deubler (1958) they found a combination of meristic characters the most valid index for species separation.

In this paper we describe artificially fertilized summer flounder eggs and larvae hatched in the laboratory or captured at sea.

METHODS

In December 1965 we began a 1-year survey consisting in eight cruises on the Continental Shelf from Martha's Vineyard, Mass., to Cape Lookout, N. C., to investigate offshore spawning of several game fishes. To substantiate indentification of pelagic fish eggs taken during the survey, we sometimes cultured artificially fertilized eggs to compare with field collections.

Procedural details, hydrographic data, and equipment used during the 1965–66

field survey are described by Clark et al. (1969). During each cruise we sampled from surface to 33 meters at 92 predetermined stations. Two Gulf V nets were used to collect plankton, sampling at 3–meter depth intervals in a step-oblique pattern. One sampler fished from surface to 15 meters; the other from 18 to 33 meters. Larvae over 4 mm described in this study were among 3,000 collected during the survey; those under 4 mm were reared artificially.

We artificially fertilized eggs on October 23, 1968, after taking gravid summer flounders in a series of half-hour otter-trawl tows about 37 km east to east-southeast of Absecon Inlet, N. J. Water depths ranged from 26 to 37 meters. Starting half an hour after fertilization, we preserved eggs at increasing time intervals of one-half to 4 hours. We took samples at 6–hour intervals from 14 through 122 hours after fertilization, then daily through 192 hours. Water temperature dropped from 18.3° to 15.5° C. during the egg hatching period. Salinity remained constant at 32 o/oo.

Eggs and larval stages were examined through a binocular microscope at magnifications of ×15 to ×45. An ocular micrometer and grid facilitated accurate delineation of the specimens. All counts, measurements, and descriptive observations of larvae were taken from the left side.

Early larvae were measured from the anterior edge of the head or tip of the snout to the tip of the notochord. These measurements are expressed as notochord length (NL). Subsequent to formation of the hypural bones, larval measurements from the tip of the snout to the base of the median caudal rays are expressed as standard length (SL). Head length (HL) was measured from the tip of the snout to the cleithrum along the longitudinal axis. The body depth was measured from the anus to the base of the dorsal fin on a line perpendicular to the longitudinal axis of the body. Other measurements and counts conform to those prescribed by Ahlstrom and Ball (1954) and Hubbs and Lagler (1958). All measurements were recorded to the nearest hundredth of a millimeter.

EGG DEVELOPMENT

It was evident from our artificially fertilized eggs that development was inconsistent within a sample. Consequently we considered it impractical to discuss the rate of development, choosing instead to describe diagnostic characters of eggs during three developmental phases.

Phase I encompasses the time between fertilization and closure of the blastopore about 32 hours later. Dimensions of the egg, yolk, and oil globule are most helpful for identifying eggs in this phase (table 1).

Fertilized eggs are spherical, with a transparent but rigid shell. The perivitelline space occupies about 6 percent of the egg radius, varying in early-stage eggs because the yolk mass is not always centered. As the embryo develops, the yolk becomes more centrally located. The yolk mass of preserved eggs is white and opaque when observed with direct light but appears yellow-amber and translucent when seen with reflected light.

All developing eggs held in the laboratory have one spherical oil globule. Some eggs taken at sea have a single oil globule surrounded by several smaller droplets. We believe these droplets are artifacts resulting from fractures of the oil globule, possibly upon contact with the sampler.

The oil globule is at the vegetal pole during early development, opposite the

blastodisc (plate 1, *a*). At the time of blastopore closure, the notochord and anlagen of eyes are discernible and the embryo extends approximately half the circumference of the yolk mass. Myomeres are not yet apparent, and pigment is lacking.

Phase II begins with blastopore closure and ends when the embryo bends out of its axial plane at about 54 hours.

Soon after the blastopore closes, myomeres are evident but difficult to count. The number of myomeres varies from 14 to 17 when first visible, being most evident at midembryo (plate 1, *b*).

Granular melanophores first appear randomly scattered on the trunk of the embryo. The head and posterior trunk are usually devoid of pigment, but a few melanophores are evident on the head and tail of some specimens. Pigment is generally lacking on the yolk sac, but specimens occur on which melanophores are sparsely scattered along the embryonic axis and around the oil globule. About 20 myomeres are visible when pigment appears.

By the end of phase II, the enlarged embryo shows increased pigmentation on the trunk and head, the caudal region is pigmented, and rudiments of the finfold are evident posteriorly (plate 1, *c*). The tail, free from the yolk sac, extends to or overlaps the oil globule, and posteriorly the embryo curves laterally out of its axial plane. Melanophores are apparent on the periphery of the ventral two-thirds of the yolk sac. Some specimens have dendritic melanophores, while on others pigment remains granular. Twenty-seven myomeres are evident.

Phase III encompasses development of the egg from bending of the embryo through hatching. Eyes become defined as the embryo enlarges but remain unpigmented (plate 1, *d*). Myomeres increase from about 27 during this phase to 39–41 at hatching. The growing embryo eventually surrounds the yolk. Before hatching, the oil globule is positioned at the margin of the anal finfold near the developing vent.

As development proceeds, melanophores become increasingly dendritic on the trunk and even more so on the dorsal and anal finfolds, which continue to widen. Pigment is randomly distributed on the embryo except the posterior tailbud and caudal finfold, which are clear. Although the head has additional pigment, the melanophores are usually more granular than those on the trunk and finfold. Pigment on the yolk varies with the specimen but is less pronounced than on the embryo.

Embryos of some phase III eggs collected at sea have a reduced oval-shaped yolk with a smaller oil globule than our artificially fertilized material (table 1). We consider these eggs to be in a more advanced stage of development than any samples from the rearing experiment because the embryos more closely resemble the hatchling (plate 2).

The eggs which we reared began to hatch between 72 and 75 hours after fertilization.

HATCHLING

The summer flounder hatchling has unpigmented eyes and no fin buds or mouth parts (plate 2). The notochord length of our preserved hatchlings ranges from 2.41 to 2.82 mm. The body is long, thin, and compressed except at the yolk mass, where it is round in cross section.

The head is flexed ventrally, and the snout protrudes only slightly from the outline. Cleithra are not formed; thus definition posteriorly is lacking, and the head cannot be measured. Eye diameter and snout length together average 0.34 mm, or slightly less than 14 percent of

the notochord length. The eye averages 0.22 mm in diameter (about two snout lengths). The eye occupies the lower half of the head, and its posterior edge is over the anterior edge of the yolk. The cranial area lacks definition, but a slight bulge indicates the developing midbrain. With proper lighting, one cranial spine per side may be seen, located near the dorsal edge of the head. Jaw and mouth elements, nares, cleithra, opercular apparatus, and branchiostegal rays are not discernible.

The yolk mass occupies about 30 percent of the notochord length. The oil globule is at the posterior edge of the yolk sac and is approximately equal to the eye in diameter. Development of the alimentary tract has not yet begun, but the developing renal tract is visible. The anus does not extend to the margin of the finfold.

The finfold is a broad structure which originates dorsally over the otocyst. Its margin is slightly concave dorsally and ventrally at the peduncle and at the location of the anus. The preanal finfold is prominent.

The notochord is straight, and a few actinotrichia are visible proximally in the caudal finfold. Although the myomeres are indistinct, 36 to 41 may be counted.

Dendritic melanophores are present on the anterior half of the ventral finfold and the anterior two-thirds of the dorsal finfold. The anterior three-quarters of the body is pigmented. Finfold and body pigmentation end abruptly, leaving the posterior quarter of the larva immaculate. Cranial pigmentation includes melanophores on the snout, overlying the midbrain, and in the area anterior to the yolk and ventral to the eye. There are a few melanophores on the anterodorsal part of the yolk; the oil globule is unpigmented.

LARVAL DEVELOPMENT

Specimens selected for illustration show several diagnostic characters, but do not always represent the initial size at which a given character becomes evident. Our descriptions are keyed to illustrated specimens. Morphometric and meristic data taken from larvae grouped into 11 size classes are presented in table 2 to show variations in development.

Body

The body retains a slim, serpentine character through our 3.16 mm NL larva, becoming slightly rounder at about 4.55 mm NL. The body begins to flatten laterally when larvae are about 7.5 to 8.5 mm NL. Metamorphosis is usually completed by 12.0 to 13.0 mm SL.

Head

In our series of larvae the head is initially flexed ventrally but is in line with the longitudinal axis of the body beginning at 3.15 mm NL (plate 4). The cleithrum is evident and the head is clearly defined at 3.16 mm NL. With larval growth the head occupies an increasing portion of the body length (table 2).

Eye

At about 3.1 mm NL, pigmentation first appears in the eye. In early larvae a choroid fissure is evident on the dorsal edge of the iris, and in our 3.16 mm NL larva there is both a dorsal and a ventral fissure (plate 5). Thereafter only the ventral fissure exists. With growth, the eye occupies a decreasing portion of the head length.

The right eye begins its migration to the left side of the skull at about 9.5 mm SL and may be seen over the dorsal edge of the skull in our 12.14 mm SL larva (plate 10). The right eye is locat-

ed on the dorsal edge of the skull in our 12.60 mm SL larva (plate 11).

Brain

The dorsal bulge of the midbrain becomes slightly more distinct through the early stages until in our 3.15 mm NL larva it is a prominent structure, remaining thus through larval development. The forebrain is first visible in our 3.16 mm NL larva (plate 5). The hindbrain is indicated by a thickening posterior to the midbrain at about 4.5 mm NL. The developing cerebellum and medulla oblongata become distinct in larger specimens.

Nares

The nares are first evident in our series of larvae at 9.47 mm NL where a low ridge appears on the snout immediately dorsal to the premaxilla (plate 8). A low craterlike ridge slightly less than the diameter of the pupil is apparent in the preocular area at 9.47 mm SL (plate 9), and a nostril is visible in the same area at 12.14 mm SL (plate 10).

Otocyst

The oval otocyst is visible in all stages through absorption of the yolk (plates 2 to 5). Its long axis varies from horizontal to vertical, but the two otoliths maintain a position slightly ventral to the center of the oval in all stages. Initially the otocyst is dorsal to the anterior portion of the yolk sac, becoming more anterior with development. At all sizes in which the otocyst is visible, its greatest diameter approximates the length of the snout.

Yolk and oil globule

The yolk diminishes with growth and appears completely absorbed in our 3.16 mm NL larva (plate 5). The oil globule maintains a fairly constant position and size approximating one eye diameter through yolk absorption, then dissipates.

Alimentary and renal tracts

The alimentary canal becomes evident, the gut begins to develop folds and convolutions, and the anus forms when the yolk is completely absorbed. After yolk absorption, the renal tract becomes more defined and terminates abruptly near the margin of the finfold. Folds and loops are visible within the renal tract in our 4.55 mm NL larva (plate 6). The anus is located at the margin of the finfold and is directed posteriorly. The terminal portion of the renal tract is directed ventrally in our 8.64 mm NL larva (plate 7). Through the remainder of larval development the renal tract becomes directed anteriorly until the posterior half of the gut is bordered by the tract and the anus is located under the midpoint of the gut. As the larva develops the preanal length occupies a decreasing portion of the body length (table 2).

Mouth

The location of the mouth is first indicated in our series of larvae by a shallow depression under the snout at 3.15 mm NL (plate 4). With absorption of the yolk, the mouth is formed and some internal jaw suspension structures are visible. The angular bone is prominent at 4.55 mm NL (plate 6). The gape in all specimens extends to a point ventral to the anterior edge of the eye. Dentition is first visible in our 9.47 mm NL larva where one tooth is located anteriorly on each premaxilla and one laterally on each dentary (plate 8). The maxilla is first visible as a prominent flat structure sloping downward from the horizontal axis of the body at 4.55 mm NL (plate 6).

Cleithrum

The cleithrum becomes faintly discernible in some specimens between 3.0 and 3.5 mm NL where its presence is revealed by a streak on the lateral surface of the body between the otocyst and the now-reduced oil globule (plate 5). Through the remaining developmental stages the cleithrum is a readily apparent structure, serving as the posterior point for measuring the head. In an unstained specimen 12.14 mm SL, the supracleithrum, postcleithrum, and basipterygium are not visible. However, Woolcott, Beirne, and Hall (1966) found that at about 11 mm these structures were ossified.

Opercular bones

With proper lighting the opercular bones can be seen immediately anterior to the cleithrum in larvae as small as 4.5 mm NL. From this length to our 9.47 mm SL larva (plate 9) the preopercle can be located by the row of five to seven spines along its margin.

Branchiostegal rays

Branchiostegal rays are evident in our series of larvae at 8.64 mm NL; the posteriormost three are long and directed posteriorly, and the two anteriormost are shorter and directed posteroventrally (plate 7). In larger specimens, six branchiostegal rays are present; the posteriormost three are longer and directed posteriorly, and the anteriormost three are directed posteroventrally.

Myomeres and vertebrae

In early larvae, myomeres can be seen faintly. Myomeres are most evident along the middle of the body, becoming increasingly evident anteriorly with growth. At about 4.5 mm NL, myomeres change from a V to a W configuration. In laterally compressed older larvae, vertebrae are discernible with reflected light. Our 9.47 mm NL larva has 39 vertebrae with the first haemal spine on the 12th vertebra. An adult complement of 11 thoracic plus 30 caudal vertebrae is present in our 9.47 mm SL larva. The urostyle begins to tip up at 9.0 to 9.5 mm NL. Hypural and epural bones are visible at abut 9.5 mm SL.

Spines

Tiny cranial spines are present on the side of the head in our series of larvae through 12.14 mm SL. One spine per side is visible in specimens through 3.15 mm NL, and two or three spines per side in later stages. The orientation of the spines cannot be determined in the smallest specimens, but beginning with our 4.55 mm NL larva they are directed anterodorsally.

At about 4.5 mm NL, five to seven posteroventrally directed spines of equal length are present on the margin of the preopercle (plate 6). Two to five opercular spines are also present in our specimens 8.64 mm NL to 9.47 mm SL (plates 7 to 9). In our specimens 12.14 mm SL and larger, none of these spines are visible.

Finfold and fins

In our series of larvae, the origin of the dorsal finfold changes from its initial position over the otocyst to a position over the eye (plates 2 and 3). Otherwise, the finfold resembles that of the hatchling through yolk absorption. The prominent preanal finfold becomes a remnant at 4.55 mm NL (plate 6). A few unbranched rays appear in the anterior portion of the dorsal finfold at 7.0 to 9.0 mm NL (plate 7). Up to 16 branched rays are visible in the caudal finfold, under the straight notochord. At 9.47 mm NL, 14 rays are visible in the anterior portion of the dorsal finfold, of which three are fim-

briated distally (plate 8). Thirteen caudal rays are evident under the tipped-up urostyle, of which five show segmentation. Elsewhere in the dorsal and anal finfolds, actinotrichia are indicated but rays are not developed. A total of 22 interneurals and 19 interhaemals are visible. Anal pterygiophores are obscured by opacity in the abdominal rod area. Dorsal and anal ray formation accelerates at about 9.5 mm SL. The fourth through eighth dorsal rays are elongated. Remnants of the finfold persist dorsally and ventrally in the area of the caudal peduncle. Variations in fin formulae during development are noted in table 2. At 12.14 mm SL, median fin ray counts fall within the adult range. The caudal fin has nine epaxial rays, eight hypaxial rays, and one faintly visible epaxial procurrent ray—a total of 18. Remnants of actinotrichia persist distally in the dorsal and anal fins.

The pelvic fin is visible as a low bud on the ventral outline immediately posterior to the cleithrum in our 9.47 mm NL larva (plate 8). Development continues until at 12.14 mm SL six rays are visible (plate 10).

Tiny pectoral buds are first visible in our series of larvae over the anterior end of the yolk sac at 3.12 mm NL. The buds are more noticeable at 3.15 mm NL, appearing as ovate flaps positioned more posteriorly. At 3.16 mm NL the developing pectoral fin is half fleshy base and half fin membrane. The posterior edge of this membrane reaches a point over the posterior edge of the yolk. Actinotrichia are evident at 4.55 mm NL (plate 6). True pectoral rays are not yet developed in our 12.60 mm SL specimen (plate 11).

Pigmentation

Pigmentation in our 3.12 and 3.15 mm NL larvae is similar to that described for the hatchling, except that additional melanophores border the otocyst dorsally and appear on the margin of the preanal finfold. Melanophores are not present in the gular area. At 3.16 mm NL, the caudal finfold is unpigmented except for a few melanophores at its base. There is a well-defined row of pigment spots on the ventral edge of the body (plate 5).

At about 4.5 mm NL, pigment spots appear on the ventral edge of the body, gut, and throat, and melanophores are present on the lower jaw, preopercle, midbrain, dorsolateral surface of the body, and finfold (plate 6). This pigment pattern persists through our 8.64 mm NL larva, and at this length melanophores are also present dorsally along the peritoneum and on the posterolateral portion of the gut (plate 7).

Our specimens 9.47 mm NL through 12.60 mm SL are similarly pigmented. Melanophores are retained on the ventral edge of the gut, throat region, lower jaw, and dorsum of the head. The ventral row of melanophores posterior to the gut consists of 10 to 13 distinct spots. Along the body's dorsal edge six to eight widely separated spots are present. On the midflank there are usually 3 prominent melanophores posteriorly and a varying number of smaller spots anteriorly. Peritoneal pigmentation is dense dorsally. Pigmentation of the posterolateral portion of the gut now consists of three stellate melanophores. At 12.14 mm SL a large melanophore appears on the side of the head and a single melanophore is present on the midflank, immediately posterior to the cleithrum. Pigmentation on the median fins is most evident proximally, being more dense on the anal fin. At 12.60 mm SL the dorsal and anal fins are equally pigmented with melanophores situated distally between the rays.

DISCUSSION

Paralichthys dentatus ranges northward to Massachusetts, while *P. lethostigma* and *P. albigutta* do not range beyond North Carolina (Ginsburg, 1952). We therefore assumed all *Paralichthys* larvae caught in the northern part of the survey area to be *P. dentatus*. We confirmed the identity of specimens caught off New York and New Jersey by compiling meristic data from the largest postlarvae, then examining progressively smaller specimens. Subsequently, we were able to identify *P. dentatus* in samples from the southern part of the survey area where all three species occur. We compiled the data in table 2 from measurements of *P. dentatus* larvae caught throughout the survey area during different cruises to show the ranges in morphometric and meristic data among specimens of comparable size.

Flatfish larvae are characterized by their protruding midbrain, wide median fins, large anteriorly positioned gut, and laterally compressed body. *P. dentatus* larvae over 4 mm can be distinguished from other bothid flounder larvae found within the survey area by the 10 to 13 melanophores located ventrally along the body posterior to the anus.

Our larvae less than 4.0 mm NL, which were hatched from artificially fertilized eggs, lack the well-defined row of dorsal and anal fin pigment that Deubler (1958) found in his postlarval *P. dentatus*, the smallest of which was 9 mm SL (see plate 11). We were unable to determine the size at which this fin pigment forms, because the Gulf V sampler destroyed the distal portion of median fins on most of our larvae between 4 and 9 mm. However, three specimens (6.67, 7.17, 7.92 mm SL) that have median fins intact lack the row of fin pigment. Presumably this pattern appears after dorsal and anal fin rays have formed.

Our larvae of like size exhibit similar pigmentation, most variation being attributable to the state of expansion or contraction of melanophores. There is a significant difference in pigmentation between our larvae and those described as *Paralichthys* species by Hildebrand and Cable (1931). Whereas their larvae have a row of 18 or more contiguous spots of uniform size extending along the ventral edge of the body, we found a maximum of 13 spots of nonuniform size and spacing in our *P. dentatus* larvae. Their specimens through 8 mm are also more developed than any of comparable length in our collection.

We caught larvae during the 1965–66 plankton survey that resemble those described by Hildebrand and Cable (1931). All were caught in waters off North Carolina, the northernmost taken 16 km east of Cape Hatteras. The differences in pigmentation, in development with size, and in geographic distribution between the two larval types in our collection lead us to conclude that the larvae Hildebrand and Cable caught near Cape Lookout are *P. lethostigma* or *P. albigutta*.

We thank Walter Murawski of the New Jersey Division of Fish and Game for providing supplementary collections of artificially fertilized eggs for comparative studies, Arthur Kendall of the Sandy Hook Marine Laboratory for assisting with the rearing experiment, and the technicians of the laboratory for their diligent sorting of fish eggs and larvae from approximately 1,200 plankton samples taken during the survey.

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TABLE 1.—*Measurements of summer flounder eggs from artificially fertilized specimens and from field collections*

	Water temperature range °C	Number of specimens	Diameter (mm) of—					
			Egg		Yolk		Oil globule	
			Range	Mean	Range	Mean	Range	Mean
Phase I	18.3	40	0.96–1.06	1.00	0.77–0.98	0.85	0.20–0.31	0.24
Phase II	17.3–18.3	40	0.90–1.08	1.01	0.79–0.96	0.90	0.20–0.31	0.26
Phase III	15.5–17.3	40	0.98–1.08	1.02	0.82–0.96	0.90	0.20–0.29	0.25
Field collections (all phase III)	14.3–16.4	40	0.98–1.10	1.04	0.63–0.90	0.80	0.18–0.29	0.24
All phases	14.3–18.3	160	0.90–1.10	1.02	0.63–0.96	0.86	0.18–0.31	0.25

TABLE 2.—*Morphometric and meristic data for summer flounder larvae*

Specimen length (mm)		Number of specimens	Body part	Dimensions (mm)		Mean percent of specimen length	See plate No.—	Fin formulae (range)		
Range	Mean			Range	Mean			Dorsal	Caudal	Anal
2.41–2.96 NL	2.72	18	Head length[1]							
			Eye diameter	0.16–0.27	0.22	8	2, 3			
			Preanal length	1.12–1.45	1.31	48				
			Body depth	0.27–0.44	0.38	14				
3.04–3.37 NL	3.19	16	Head length[1]				4, 5			
			Eye diameter	0.19–0.25	0.23	7				
			Preanal length	1.29–1.53	1.41	44				
			Body depth	0.41–0.52	0.45	14				
4.12–4.55 NL	4.33	10	Head length	0.88–1.10	1.01	23	6			
			Eye diameter	0.27–0.36	0.33	8				
			Preanal length	1.92–2.30	2.10	48				
			Body depth	0.53–0.80	0.71	16				
5.08–5.83 NL	5.46	10	Head length	1.14–1.51	1.32	24				
			Eye diameter	0.37–0.45	0.41	8				
			Preanal length	2.25–2.58	2.44	45				
			Body depth	0.94–1.39	1.22	22				
6.00–6.83 NL	6.38	10	Head length	1.22–1.84	1.47	23		0–2		
			Eye diameter	0.37–0.45	0.41	6				
			Preanal length	2.42–2.83	2.55	40				
			Body depth	1.02–1.84	1.28	20				
7.00–7.92 NL	7.41	10	Head length	1.59–2.12	1.83	25		2–10	5–14	
			Eye diameter	0.45–0.57	0.51	7				
			Preanal length	2.75–3.33	3.09	42				
			Body depth	1.63–2.82	2.14	29				
8.00–8.83 NL	8.49	10	Head length	1.83–2.40	2.16	25	7	5–13	13–16	0–3
			Eye diameter	0.50–0.58	0.57	7				
			Preanal length	2.92–3.58	3.26	38				
			Body depth	2.33–3.25	2.78	33				
9.17–10.08 SL	9.61	10	Head length	2.33–2.67	2.49	26	8, 9	9–86	13–18	0–64
			Eye diameter	0.58–0.67	0.65	7				
			Preanal length	3.33–3.75	3.53	37				
			Body depth	3.08–4.08	3.56	37				
10.50–11.00 SL	10.71	10	Head length	2.58–3.08	2.91	27		84–92	18	65–72
			Eye diameter	0.67–0.75	0.72	7				
			Preanal length	3.33–4.17	3.66	34				
			Body depth	4.00–5.00	4.41	41				
11.25–11.92 SL	11.42	9	Head length	2.83–3.33	3.07	27		86 92	17–18	65–71
			Eye diameter	0.67–0.83	0.73	6				
			Preanal length	3.50–4.25	3.82	33				
			Body depth	4.42–5.50	5.06	45				
12.08–13.08 SL	12.62	7	Head length	2.92–3.33	3.17	25	10, 11	87–91	17–18	67–69
			Eye diameter	0.67–0.83	0.77	6				
			Preanal length	3.50–4.42	3.81	30				
			Body depth	5.00–5.42	5.23	41				

[1] Unmeasurable, cleithrum not ossified.

PLATE 1.—Summer flounder eggs: a, phase I; b, early phase II; c, late phase II; d, phase III. Figures oriented with ventral aspect uppermost.

PLATE 2.—Summer flounder hatchling 2.78 mm NL sampled 75 hours after artificially fertilizing eggs.

PLATE 3.—Summer flounder larva 3.12 mm NL sampled 12 hours after hatching.

PLATE 4.—Summer flounder larva 3.15 mm NL sampled 36 hours after hatching.

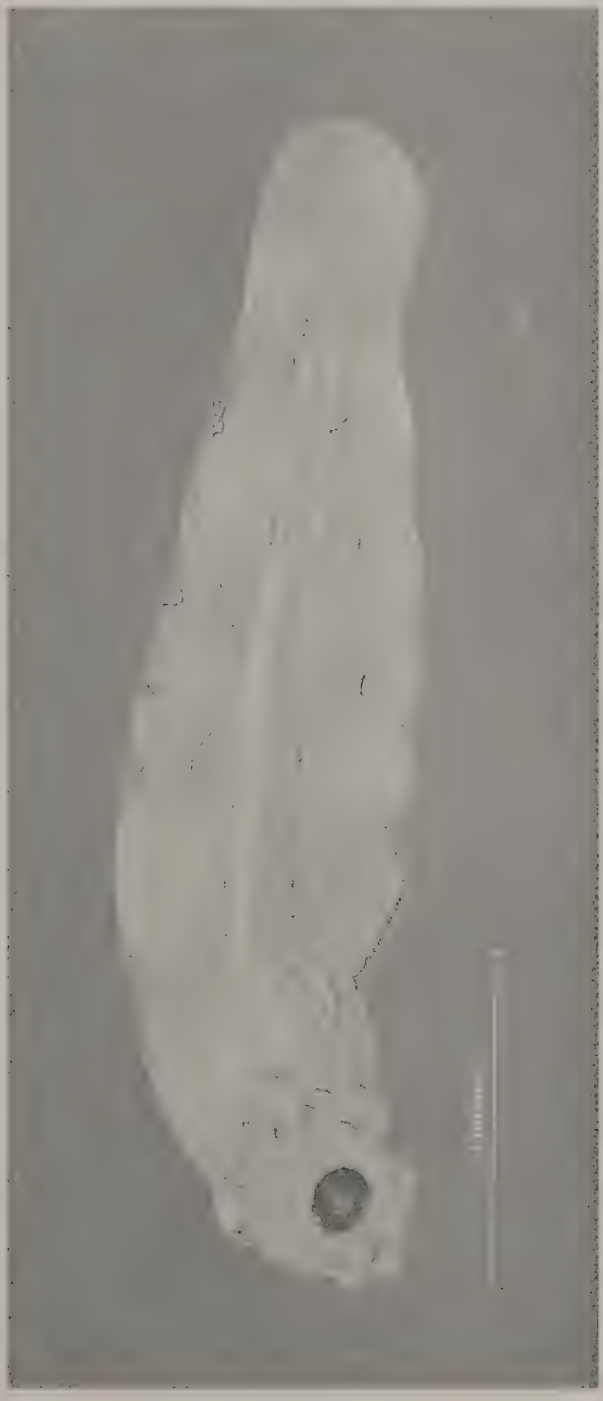

PLATE 5.—Summer flounder larva 3.16 mm NL sampled 96 hours after hatching.

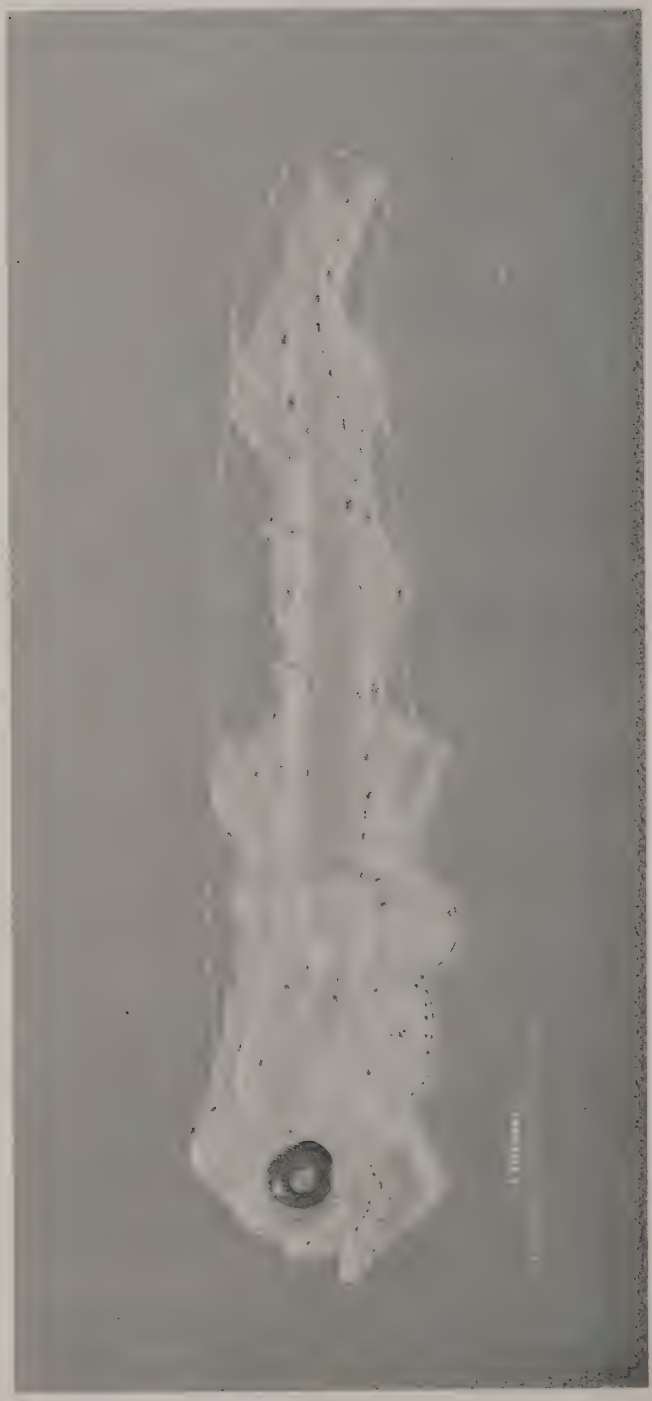

PLATE 6.—Summer flounder larva 4.55 mm NL taken Oct. 4, 1966, at 38°21.0'N., 74°13.5'W.

PLATE 7.—Summer flounder larva 8.64 mm NL taken Jan. 25, 1966, at 40°20.0'N., 71°35.0'W.

PLATE 8.—Summer flounder larva 9.47 mm NL taken Feb. 8, 1966, at 35°12.5'N., 75°12.0'W.

PLATE 9.—Summer flounder larva 9.47 mm SL taken Feb. 8, 1966, at 35°12.5'N., 75°12.0'W.

PLATE 10.—Summer flounder larva 12.14 mm SL taken Dec. 1, 1966, at 39°51.5'N., 74°04.0'W.

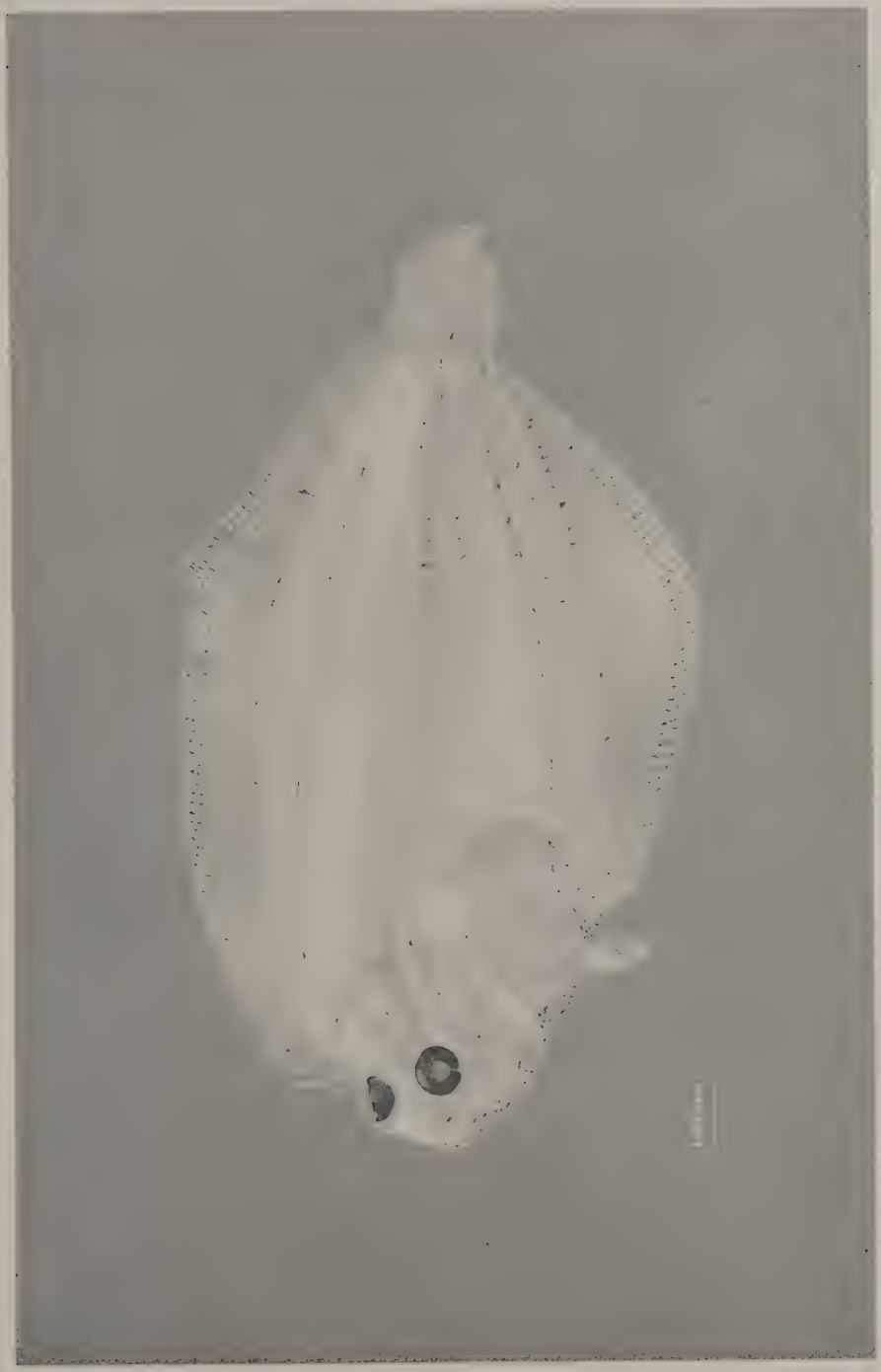

PLATE 11.—Summer flounder larva 12.60 mm SL taken Dec. 13, 1965, at 35°46.5'N., 75°30.0'W.

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RESEARCH REPORTS—Continued.

73. Predatory Behavior of Some Shore Fishes in the Gulf of California, by Edmund S. Hobson. 1968. 92 p.
74. Ecology of Daphnia in Bull Shoals Reservoir, by Richard L. Applegate and James W. Mullan. 1970.

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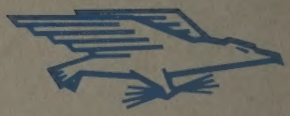

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